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EFFECTS OF WIND ON GUNNER AIMING ERROR--AN EVALUATION OF FIELD TEST DATA

Gerald Chaikin, et al

Army Missile Command
Redstone Arsenal, Alabama

18 August 1972

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ABSTRACT

This report presents data from a field investigation of aiming error as a function of launcher weight and tracking rate for manportable air defense system applications under calm and windy conditions. The effects of calm and 15-knot wind conditions are examined in terms of aiming error at the point of uncage for launcher weights of 30, 35, 40, 45 and 50 pounds and tracking rates of below 1, 1 to 4, 4 to 7, and above 7 degrees per second.

CONTENTS

Section I. INTRODUCTION

1. Background

An investigation of aiming error as a function of launcher weight was conducted using high performance jet aircraft as targets on 22, 23, 24 and 29 November 1971. Four hundred trials were run with expended REDEYE launchers modified to STINGER length and balance configurations. Aiming error at uncage was measured for launcher weights upward from that approximating launcher weight for STINGER—30, 35, 40, 45 and 50 pounds. Four tracking rates were used: under 1°/sec, 1 - 4°/sec, 4 - 7°/sec and above 7°/sec.

This field test was undertaken in conjunction with the Lighweight Air Defense System/Advanced Manportable Technical and Operational Capabilities (LADS II/AMTOC II) tests conducted from 15 November to 2 December 1971 at Yuma Proving Ground, Arizona. The investigation of aiming error as a function of launcher weight was not completely integrated into the overall LADS II/AMTOC II test plan or instrumentation, but employed the LADS II/AMTOC II high performance aircraft as targets and utilized available communication to meet specific subtest objectives. Test conditions and results were reported by Chaikin et al.[1]

During 30 November and 1 December, 150 trials were run using helicopter targets. Since these helicopters were scheduled to be flown in conjunction with the LADS II/AMTOC II tests, and since instrumentation, test gunners, test team and equipment were already in place, it was decided to secure this additional data.

An examination of the meteorological data for the two days of helicopter trials, alluded to above, disclosed that conditions were calm (0 - 2 knots) the first day and windy (14 - 15 knots) the second day during the hours when aiming error measurements were taken. Consequently, it was decided to reduce this "helicopter test" data to see if some inferences could be drawn in terms of wind effects on the 60-inch launcher. This was felt to be particularly valuable since several test subjects had recorded comments on the post-test questionnaire to the effect that high winds impaired their ability to track and aim.

2. Approach

The test was a continuation of trials reported by reference 1 with the exception that only gunner aiming error at uncage was investigated. Post uncage task data—lead, superelevate and fire—as a function of weight and rate were not evaluated due to the small sample size.

3. Constraints

a. General. With the exception of number of flights planned, targets, flight profiles and target speed, the constraints on securing aiming error data against the helicopters were the same as those for

investigating aiming error as a function of launcher weight when using the high performance jet aircraft as targets as described in reference 1.

b. Number of Flights. Forty flights were planned.

c. Targets. Helicopters participating in the LADS II/AMTOC II recognition test, and used for this aiming error subtest, included a UH-1E, CH-46, CH-53, AH-1G and UH-34.

d. Tracking Rates. Flight profiles for the helicopter targets are shown in Figure 1. Because of the practical constraints, benefits of maintaining consistency with the jet aircraft tests, and a desire to use a balanced test matrix for the 10 test subjects, 5 launchers and 40 flights to be run, it was decided to use the same tracking rate intervals used during the jet aircraft test: A - below 1°/sec, B - 1 to 4°/sec, C - 4 to 7°/sec and D - above 7°/sec.

As stated in the LADS II/AMTOC II test plan (2), no attempt was made to maintain a common speed among the various types of helicopters, but each was to maintain constant speed throughout the test. Because of inconsistent speed between targets resulting from a desire to employ tactical penetration speeds for the individual helicopters, available tracking rates could not be precisely determined prior to the test as had been done for the high performance jet aircraft; however, the relationship between available tracking rate and time (or range) from crossover was worked out for a nominal helicopter speed of 100 knots. By so doing, it was possible to allocate profiles to desired tracking rate class intervals. As will be noted later, the actual tracking rates used for the test engagements were based on track rate readouts secured from a viscous-damped tracker at the test site. The relationship between tracking rate and time from crossover is contained in Appendix A and graphically shown in Figure 2.

Since data collection methods called for uncage-after-command, it was felt that a minimum of appr[illegible] 3 seconds would be required from target entry into the [illegible] interval to the time it left that interval. An additio[illegible] was prohibition of engagements at launcher elevations abo[illegible] constraints were similar to those experienced during pl[illegible] tests using the high performance jet aircraft, noted b[illegible], which established the tracking rate class intervals for the [illegible] test.

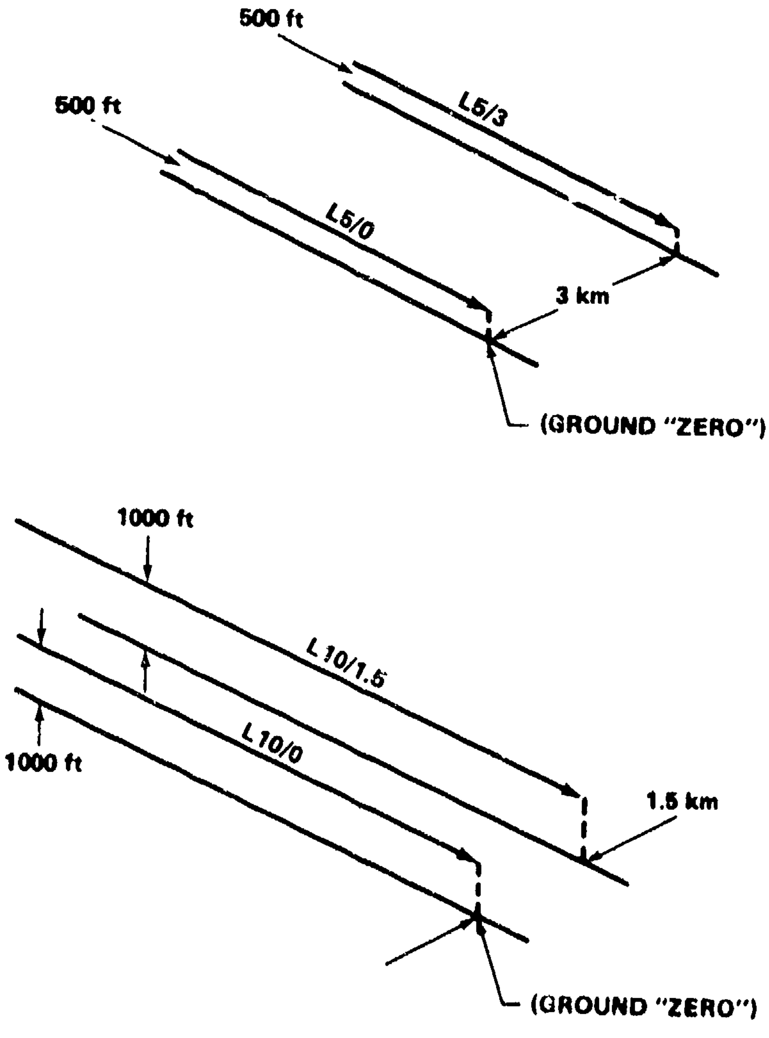


Figure 1. Flight Profiles for Rotary-Wing Aircraft

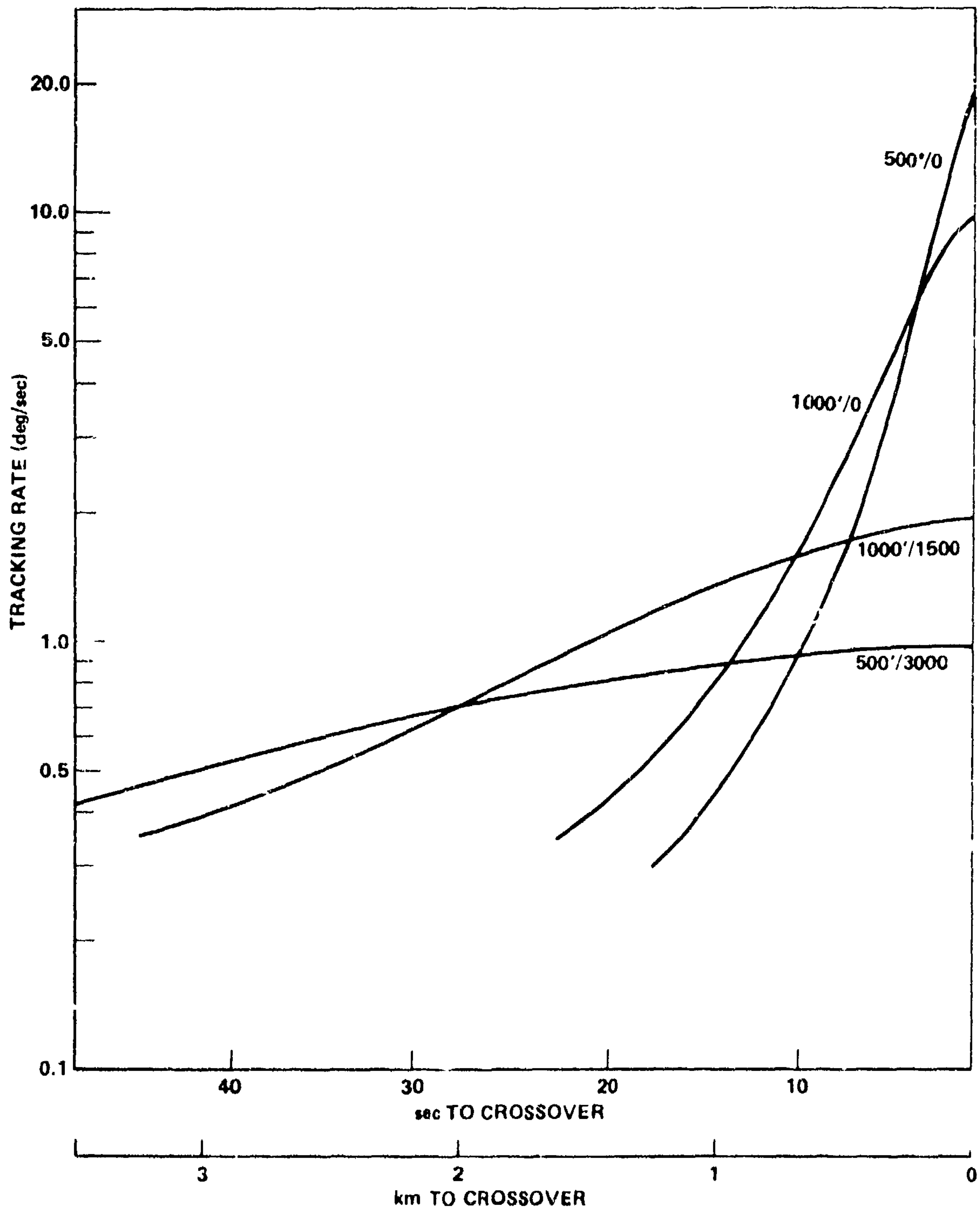


Figure 2. Tracking Rate Versus Time (Distance to Crossover)

Section II. TEST MATERIEL AND INSTRUMENTATION

Test devices and equipment items were identical to those used during the investigation of aiming error against jet aircraft as a function of launcher weight, described in detail in reference 1.

Five expended launchers were modified to (a) incorporate a TV camera mount and (b) connection of the uncage and firing switches to a tone generator for annotation of uncage and fire events on the audio channel of the video tape. Each launcher, 60 inches long, was weighted and balanced to yield one fixed weight launcher at 30, 35, 40, 45 and 50 pounds. Each TV camera, boresighted to the launcher, was connected to a recorder positioned approximately 1 foot above the ground on the launcher crate. Each camera was controlled from its recorder; each recorder was turned on and off using a switchbox on the end of a 6-foot cable.

An available, manually operated, viscous-damped tracker with track rate readout was used for indicating when the desired track rates were achieved to serve as a basis for giving uncage commands.

The test launchers were placed in cradles when not in use. These cradles consisted of two upright slats, with semicircular cutouts on top, inserted in the shipping crates.

A field phone was available at the test site to alert the test conductor to presence and range of inbound targets. Other test devices and instrumentation such as TV playback unit, monitor, tape and film supply, forms, power supplies, bullhorn, and cabling are listed in reference 1.

Section III. PLANNED TEST MATRIX AND FLIGHT SEQUENCE

1. Aiming Error at Uncage

The subjects who participated in the jet aircraft test had been divided into five teams of two each so every subject served as a gunner for half the trials and as an observer for half the trials. This arrangement was maintained during the helicopter test which was structured for each subject to experience each of four tracking rates at each of five launcher weights with one replication, thereby securing 200 data points using 40 flights. A matrix of these planned data points appears as Table 1.

Table 1. Subject Treatments

Total	200																				
Weight*		VL 40				L 40				M 40				H 40				VH 40			
Track Rate**		A 10	B 10	C 10	D 10	A 10	B 10	C 10	D 10	A 10	B 10	C 10	D 10	A 10	B 10	C 10	D 10	A 10	B 10	C 10	D 10
Subjects	1																				
	2																				
	3																				
	4																				
	5																				
	6																				
	7																				
	8																				
	9																				
	10																				

*VL = 30 lb, L = 35 lb, M = 40 lb, H = 45 lb, and VH = 50 lb

**A = below 1 deg/sec, B = 1 to 4 deg/sec, C = 4 to 7 deg/sec, and D = above 7 deg/sec.

2. Flight Sequences

A flight sequence (Table II) was prepared along with a recommended flight schedule which was given to the LADS II/ANTOC II test director.

3. Flight Sequence Sheets

The sequence presented in Table II and the information in the LADS II/ANTOC II flight schedule were combined into flight sequence sheets (Appendix B), showing flight number, rate, rate readout value, quadrant/clock direction from which the aircraft would appear, characteristics of the flight profile, launcher assignments and space for time recording and other annotations. These sheets were used for planning purposes and as an on-site aid by the test conductor and monitor personnel. Test subjects were not given access to these sheets which were used in the same way as for the jet aircraft tests.

4. Gunner Assignment Forms

Gunner assignment forms, showing flight number, gunner number, clock, and a space for recording time-of-trial and other annotations, were given to each gunner-observer team to assist them in determining which launcher to use, which team member would serve as a gunner, and the general direction from which the target would approach. The use of the gunner assignment form (Appendix C) was identical to its use during the jet aircraft tests.

Table II. Planned Flight Sequence (Camera 1 - 10)

Flight	Rate	Launchers				
		VL	L	M	H	VH
1	C	1	2	3	4	5
2	A	1	2	3	4	5
3	C	1	2	3	4	5
4	D	1	2	3	4	5
5	B	6	7	8	9	10
6	A	6	7	8	9	10
7	B	6	7	8	9	10
8	D	6	7	8	9	10
9	C	5	1	2	3	4
10	D	5	1	2	3	4
11	A	5	1	2	3	4
12	B	5	1	2	3	4
13	A	10	6	7	8	9
14	C	10	6	7	8	9
15	D	10	6	7	8	9
16	B	10	6	7	8	9
17	A	2	3	4	5	1
18	A	2	3	4	5	1
19	B	2	3	4	5	1
20	B	2	3	4	5	1
21	D	7	8	9	10	6
22	C	7	8	9	10	6
23	C	7	8	9	10	6
24	D	7	8	9	10	6
25	C	4	5	1	2	3
26	D	4	5	1	2	3
27	C	4	5	1	2	3
28	A	4	5	1	2	3
29	B	9	10	6	7	8
30	A	9	10	6	7	8
31	B	9	10	6	7	8
32	D	9	10	6	7	8
33	A	3	4	5	1	2
34	C	3	4	5	1	2
35	B	3	4	5	1	2
36	A	3	4	5	1	2
37	D	8	9	10	6	7
38	B	8	9	10	6	7
39	C	8	9	10	6	7
40	D	8	9	10	6	7

Section IV. TEST SUBJECTS, TEST SITE AND PROCEDURES

Test subjects, test site and procedures were identical to those for the investigation of aiming error as a function of launcher weight using high performance jet aircraft as targets (reference 1).

Ten qualified REDEYE gunners served as test subjects. They were not given the weights of the launchers, but were advised that the weights varied from a value below that of the trainer to above that of the trainer. All discussions and instructions relating to launcher weight were expressed as very light (VL), light (L), medium (M), heavy (H) and very heavy (VH). Team assignments were unchanged from the previous test.

A graphic portrayal of site procedures and a table of recorded tracking and annotation, extracted from reference 1, are shown in Figure 3 and Table III respectively.

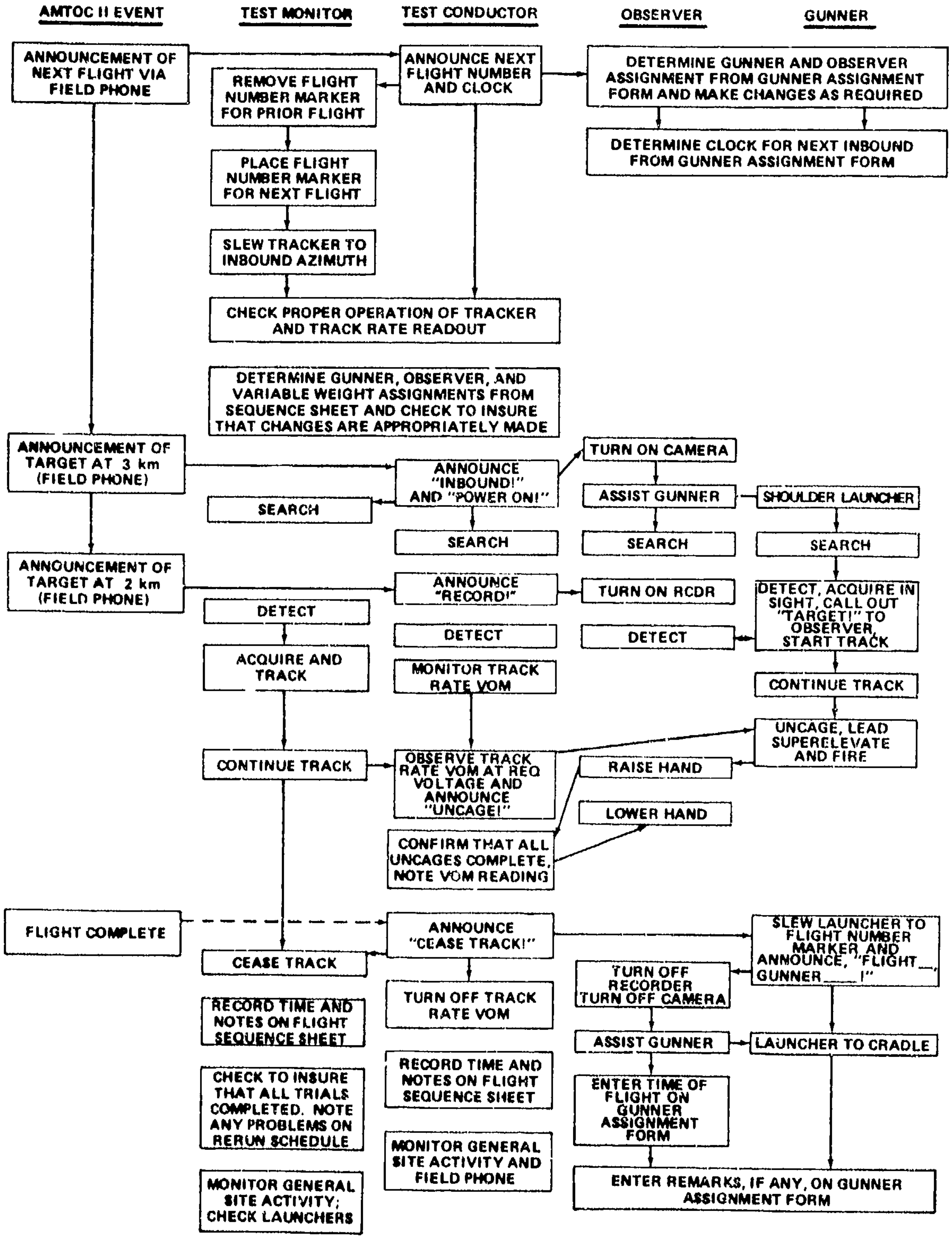


Figure 3. Site Procedures

Table III. Recorded Tracking and Annotation

Fixed Weight Launchers			Variable Weight Launcher	
Target Tracking Data (TV)	Annotation	Event	Annotation	Target Tracking Data (Film)
		"Inbound and Power On!" announced		
		"Record!" announced		
	Audio	"Mark!" announced		
	Audio	"Uncage!" announced		
	Tone on (audio)	Uncage	Lights on	
	Tone on (audio)	Lead/SE	Lights on	
	Tone off (Audio)	Fire	Lights off	
		Resume Track		
		"Cease Track!" announced		
	Video and Audio	Post-Trial Annotation	Filmed	
	*	Recorders and Camera off	*	

*Time of trial completion and remarks noted on gunner assignment form (by gunner/observer) and on flight sequence sheet (by test conductor/monitor)

Section V. DATA COLLECTION

1. General

The field test was conducted at the KOFA Range on 30 November and 1 December 1971.

2. Flight Sequence

As a result of aircraft availability, fuel management and related factors, it was necessary for the LADS II/AMTOC II test personnel to modify the planned test sequence. Actual flight order, correlated to the flight sequence sheet (Appendix B), is presented in Table IV. As with the jet aircraft test, targets appeared in a relatively random order, requiring frequent launcher changes for each team and frequent gunner-observer rotation. It is also noted that the helicopter test was terminated after 30 flights.

3. Boresight

Boresight alignment between cameras and sights was maintained or recorded for correction during data reduction.

4. Meteorological Data

Visibility during the data collection period ranged from 10+ to 15+ miles. During the first day's data collection period, wind conditions did not exceed 3 knots. The second day's wind conditions were 14 to 15 knots. An hourly summary of the meteorological conditions experienced during the testing period, collected by the US Army Meteorological Team, Yuma Proving Ground, appears as Appendix D.

Table IV. Actual Flight Sequence Versus Planned Flight Sequence

Calm (0 - 3 knots) 30 November 71		Wind (14 - 15knots) 1 December 71	
Tape Order	Flight No.	Tape Order	Flight No.
1	1	12	3
2	13	13	19
3	4	14	36
4	24	15	22
5	11	16	12
6	21	17	17
7	2	18	30
8	35	19	9
9	20	20	33
10	8	21	23
11	25	22	5
		23	7
		24	10
		25	27
		26	40
		27	6
		28	14
		29	39
		30	31

Section VI. RESULTS

1. General

Since the basic objective of the intended subtest involved aiming error as a function of launcher weight and tracking rate against high performance jet aircraft, all video tapes of the helicopter trials were temporarily stored. When evaluation of the primary (high performance jet aircraft) test data was complete, it was decided to reduce the helicopter test data, in view of the rather consistent calm conditions the first day and the consistent windy conditions the second day, to see if some inferences could be drawn in terms of wind effects on the 60-inch launcher.

2. Data Reduction

Aiming errors at uncage were measured in mils for X and Y coordinates, boresight corrections were applied in accordance with taped boresight presentations, and results converted into radial aiming error. From a possible 150 data points, 134 were recorded. Missing data resulted from conditions arising during trials which could not be rerun.

3. Results

Radial aiming errors at uncage (raw data) are tabulated in Table V which follows. Average radial aiming errors at uncage as a function of launcher weight for calm and windy conditions are graphically summarized in Figure 4. Average radial aiming errors at uncage as a function of tracking rate for calm and windy conditions are graphically summarized in Figure 5.

Table V. Radial Aiming Error at Point of Uncage

Wind	Launcher Weight	Tracking Rate*	Gunner	Order	Radial Aiming Error (mils)
Calm	VL (30 Lbs)	A	10	1	5
			5	3	3
			1	4	4
		B	3	5	4
			2	6	8
		C	1	1	12
			4	7	8
		D	1	2	11
			7	2	10
			6	4	6
	L (35 Lbs)	A	6	1	2
			1	3	2
			2	4	1
		B	4	5	14
			3	6	9
		C	2	1	9
			5	7	5
		D	2	2	15
			8	2	7
			7	4	6
	M (40 Lbs)	A	7	1	6
			2	3	6
			3	4	9
		B	5	5	3
			4	6	2
		C	3	1	11
			1	7	0
		D	3	2	4
			9	3	4
			8	4	13
	H (45 Lbs)	A	8	1	4
			3	3	4
			4	4	2
		B	1	5	3
			5	6	4
		C	4	1	4
		D	4	2	9
			10	2	10
			10	3	0
	VH (50 Lbs)	A	9	1	3
			4	3	3
			5	4	2
		B	2	5	3
		C	5	1	1
			3	7	4

*A: < 1 deg/sec, B: 1 to 4 deg/sec, C: 4 to 7 deg/sec, D: > 7 deg/sec

Table V. Continued

Wind	Launcher Weight	Tracking Rate*	Gunner	Order	Radial Aiming Error (mils)
Calm	VH (50 lbs)	D	5	2	3
			6	2	11
			6	3	1
			10	4	15
Strong	VL(30 Lbs)	A	9	2	10
			3	3	21
			2	5	7
			3	7	8
			6	7	6
		B	2	2	13
			5	4	24
			6	4	5
			6	5	8
			9	10	7
		C	1	1	10
			7	1	10
			10	8	9
			4	9	4
			8	9	4
		D	8	6	10
			5	8	4
	L (35 Lbs)	A	10	2	8
			4	3	3
			3	5	3
			4	7	4
			7	7	4
		B	3	2	17
			1	4	12
			7	4	1
			7	5	7
			10	10	6
		C	2	1	5
			8	1	4
			8	3	4
			1	6	4
			6	8	3
			9	9	5
		D	1	8	8
	M (40 Lbs)	A	6	2	8
			5	3	6
			4	5	8
			5	7	7
		B	8	7	3
			4	2	9
			2	4	3
			8	4	3
			8	5	5

*A: < 1 deg/sec, B: 1 to 4 deg/sec, C: 4 to 7 deg/sec, D: > 7 deg/sec

Table V. Concluded

Wind	Launcher Weight	Tracking Rate*	Gunner	Order	Radial Aiming Error (mils)
Strong	M(40 Lbs)	C	3	1	15
			9	1	8
			9	3	7
			2	6	6
			7	8	5
			1	9	6
			10	9	4
		D	10	6	2
			2	8	8
	H (45 Lbs)	A	7	2	9
			1	7	6
			9	7	4
		B	9	4	7
			9	5	2
			7	10	2
		C	4	1	3
			10	3	9
			3	6	4
			8	8	7
			2	9	3
			6	9	4
		D	6	6	5
			3	8	0
	VH (50 Lbs)	A	8	2	20
			2	3	6
			1	5	6
			2	7	4
			10	7	5
		B	1	2	4
			4	4	1
			10	4	2
			10	5	1
			8	10	3
		C	5	1	3
			6	1	2
			6	3	3
			4	6	14
			9	8	3
			3	9	7
			7	9	5
		D	7	6	4
			4	8	3

*A: < 1 deg/sec, B: 1 to 4 deg/sec, C: 4 to 7 deg/sec, D: > 7 deg/sec

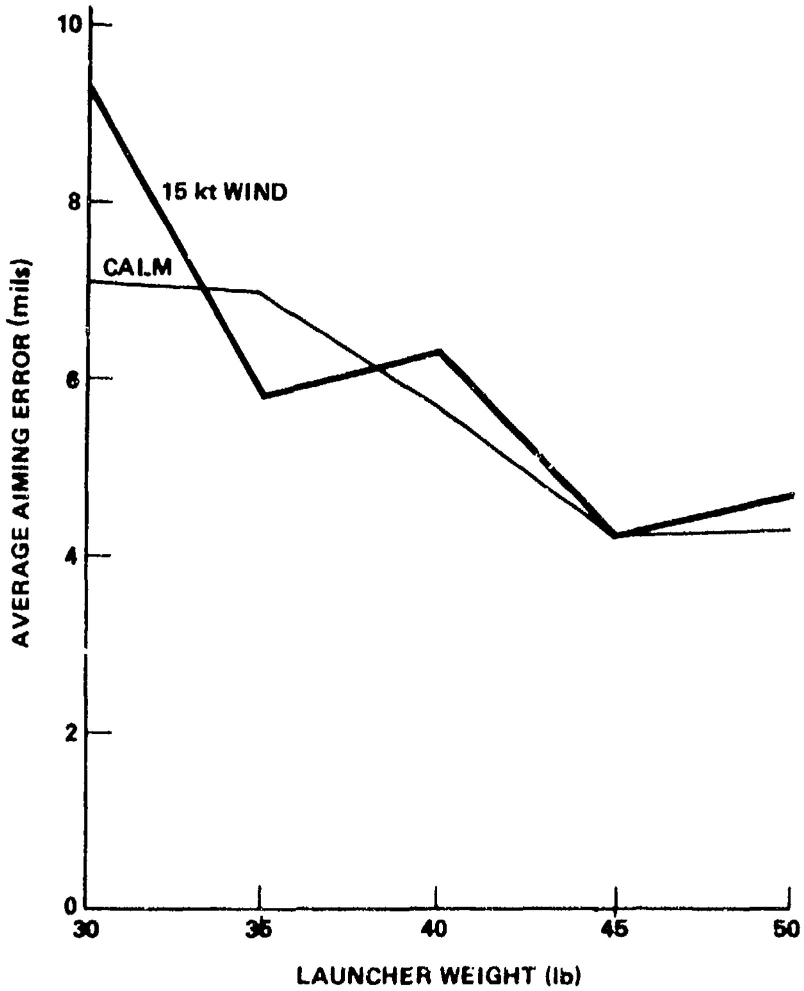


Figure 4. Average Aiming Error at Uncage as a Function of Weight: Calm & 15-kt Wind (All Trials)

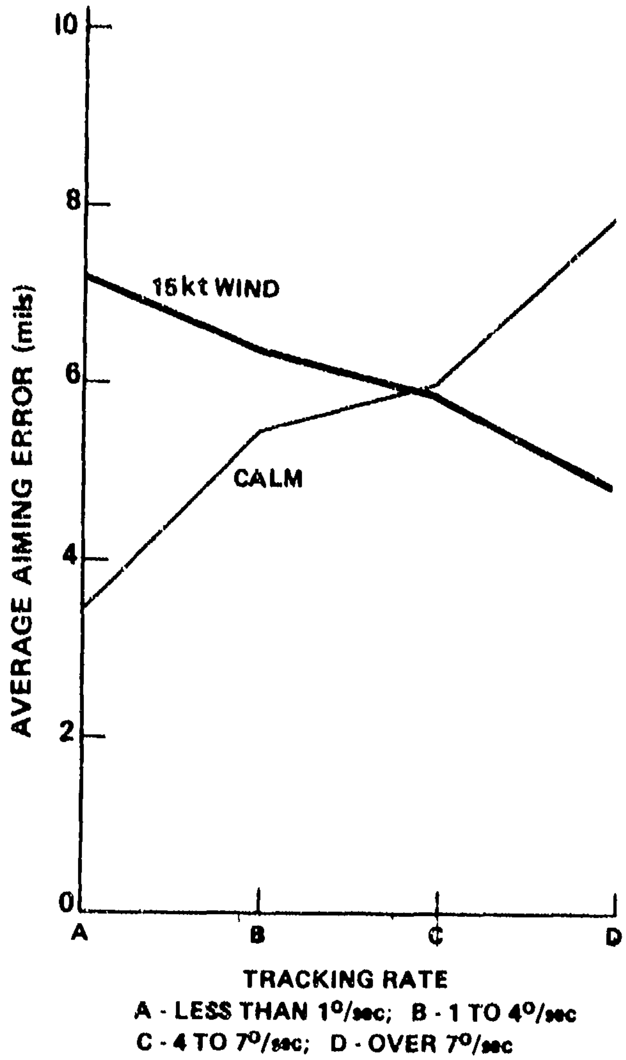


Figure 5. Average Aiming Error at Uncage as a Function of Tracking Rate: Calm and 15-kt Wind (All Trials)

Section VII. STATISTICAL ANALYSIS

In the 150 trials run, there were 134 valid observations. Of these, 49 were taken on the first day when the wind was relatively calm (3 knots or less) and 85 were taken on the second day when the wind was fairly strong (14 to 15 knots). The wind was taken as a qualitative factor at two levels—calm and strong.

A perusal of the raw data disclosed a daily trend toward lower radial aiming errors as the subjects accumulated experience. It was therefore decided to include in the analysis a factor for the progression of trials for each gunner within each day. For instance, the first sighting by Gunner 5, say, for the first day was given the value 1. His second sighting for that day was assigned the value 2 and so on. His first sighting for the second day was assigned the value 1, etcetera. This assignment process was used for each gunner.

The factors considered in the analysis were launcher weight, tracking rate, wind, gunner, and progression. A listing of the data is given in Table V. An analysis of variance was performed using the above five factors and various interactions. The only factors which appeared to be significant (with test level = 0.10) were launcher weight, tracking rate, wind, progression (to the first degree), the wind by rate and the wind by weight interactions. The data were fitted to a linear statistical model involving the significant factors and interactions. The radial aiming error predicted by the model decreased by 0.45 mils for each successive trial by a gunner during a day. This result cannot be extrapolated beyond the range of the experiment. In order to have consistent comparisons, the model was used to predict the values for the first trial of the day. The predicted radial aiming errors are listed in Table VI and shown graphically in Figures 6 and 7.

Table VI. Predicted Radial Aiming Error (in mils) at Usage for First Trial of Day

Tracking Rate*	Wind	Launcher Weight				
		VL (30 lbs)	L (35 lbs)	M (40 lbs)	H (45 lbs)	VH (50 lbs)
A	Calm	5.9	5.8	4.6	3.0	3.1
	Strong	12.0	8.2	8.8	7.7	7.7
B	Calm	8.8	8.7	7.6	6.0	6.1
	Strong	11.3	7.5	8.0	7.0	6.9
C	Calm	8.4	8.3	7.2	5.6	5.7
	Strong	11.1	7.3	7.8	6.8	6.7
D	Calm	10.1	10.0	8.8	7.2	7.3
	Strong	9.7	6.9	7.5	6.4	6.4

*A: < 1 deg/sec, B: 1 to 4 deg/sec, C: 4 to 7 deg/sec, D: > 7 deg/sec

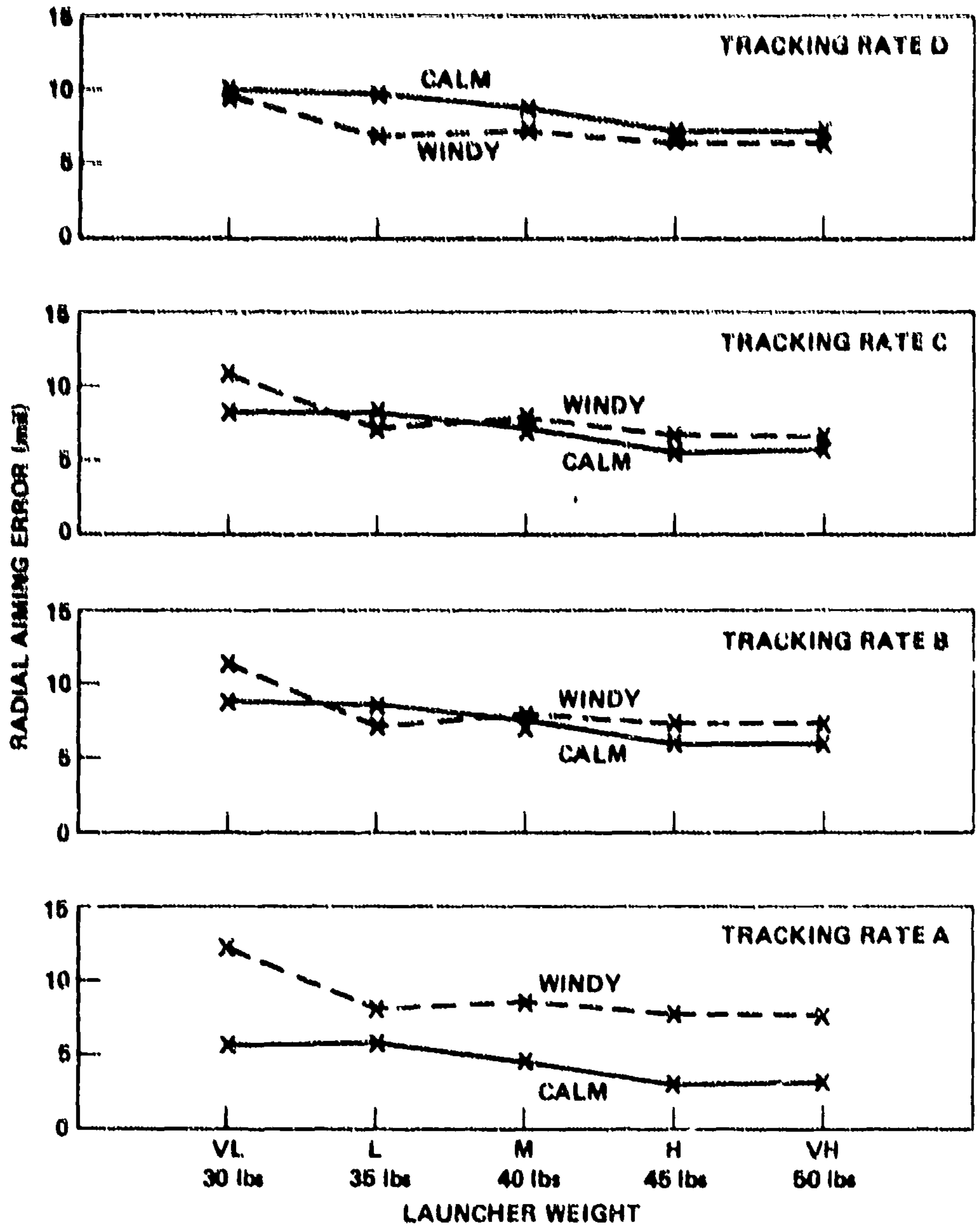


Figure 6. Predicted Radial Aiming Error (in mils) at Uncage for First Trial of Day versus Launcher Weight

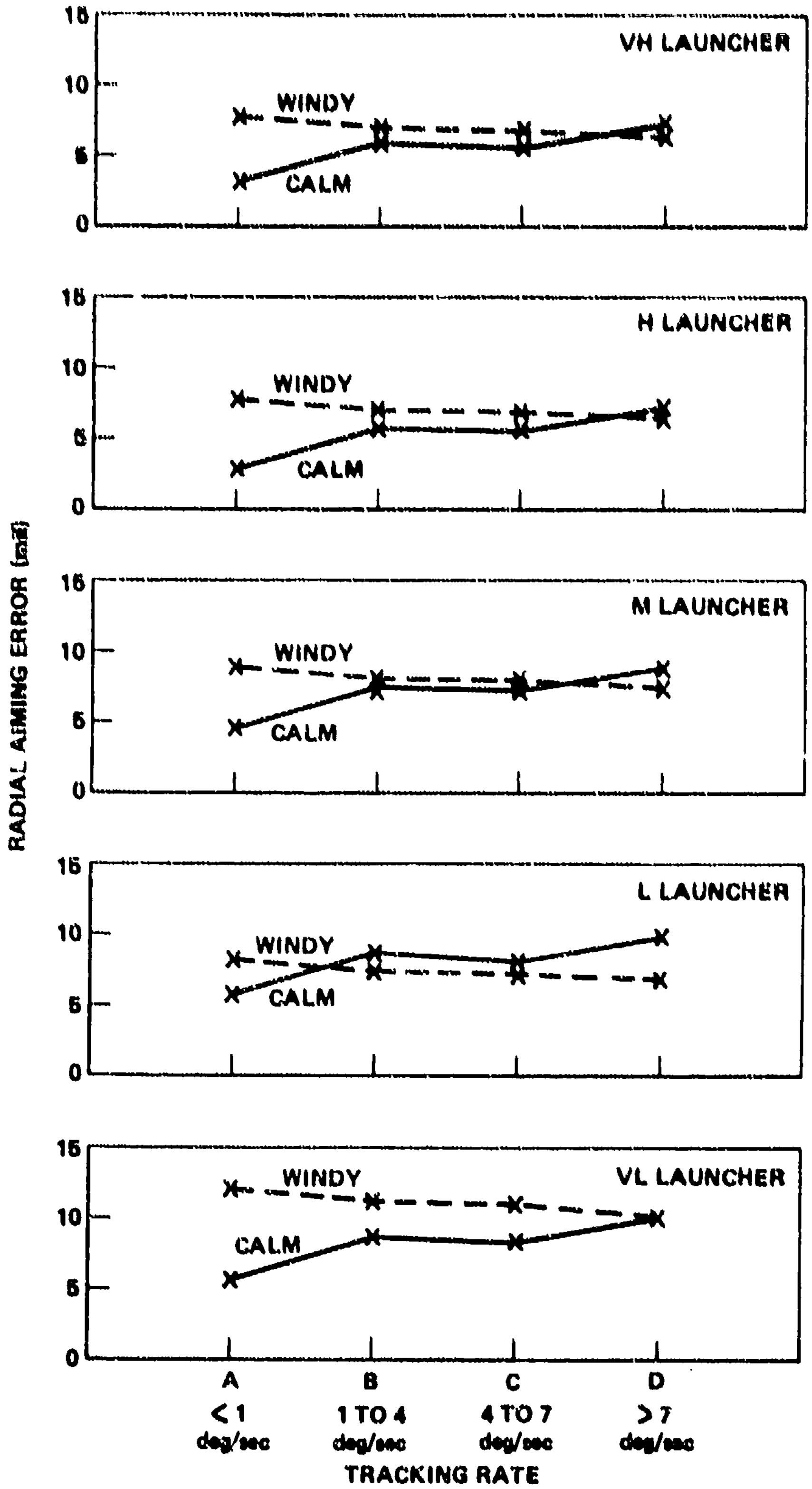


Figure 7. Predicted Radial Aiming Error (in mils) at Uncage for First Trial of Day versus Tracking Rate

Section VIII. DISCUSSION

The data analysis shows that (a) aiming error at uncage for the VL (30 pound), 60-inch launcher at low tracking rates is significantly degraded by 15-knot winds and (b) as the tracking rate increases, the degradation decreases.

Degradation of aiming error by the wind is not an unexpected finding since post-test questionnaires administered to the test subjects revealed four adverse comments on use of the 30 pound launcher in the wind. Furthermore, if a 15-knot wind were to impair aiming error at uncage with the 60-inch launcher, one would expect such impairment to be most prominent with the lightest launcher. As far as wind condition improvement with increase in tracking rate is concerned, it is possible that tracking at a moderate rate is less subject to perturbations by the wind than tracking at or near a zero rate.

The effects of practice seem to reduce aiming error. Average aiming errors for the first and subsequent pairs of flights for all test subjects are shown below in Table VII for all trials and the 30-pound launcher.

Table VII. Practice Effects

Trial	All Launchers		30-Pound Launcher	
	Calm	Wind	Calm	Wind
1 - 2	7.2	8.8	9.5	10.7
3 - 4	4.8	6.8	4.3	16.7
5 - 6		5.6		8.3
7 - 8		4.8		5.7

Section IX. CONCLUSIONS

The following were concluded for the test conditions investigated:

a. Aiming error at uncage, when using the 30-pound, 60-inch launcher, was significantly degraded by 14-15 knot winds. This impairment diminished as heavier launchers were used.

b. Under wind conditions radial aiming error was highest at the lowest tracking rate. As tracking rate increased, the radial aiming error under wind conditions became closer to the radial aiming error under calm conditions.

c. Aiming error under wind conditions can apparently be minimized through practice.

Section X. RECOMMENDATIONS

If weapon balance is not altered and the shoulder is cushioned, it is recommended that any prospective weight addition to the currently envisioned STINGER engagement-ready configuration be evaluated on some basis other than aiming error at uncage. Such bases are enumerated in the recommendations of reference 1. Since aiming error at uncage under wind conditions was shown to be suboptimal for the 30-pound, 60-inch launcher, it is recommended that any prospective use of launcher-mounted ancillary equipment having high aspect areas (e.g., an IFF antenna) be evaluated on the basis of adverse wind effects at such time as configuration and weight are reasonably defined.

APPENDIX A
DERIVATION OF ANGULAR TRACKING RATES AVAILABLE FROM LADS II/AMTOC II HELICOPTER TARGETS

The following parameters with associated drawings were used in the derivations of equations for angular tracking rates for three flight profiles:

G - Gunner's Position

V - Velocity of Aircraft

V_T - Tangential Component of Velocity (Perpendicular to Gunner's Line-of-Sight)

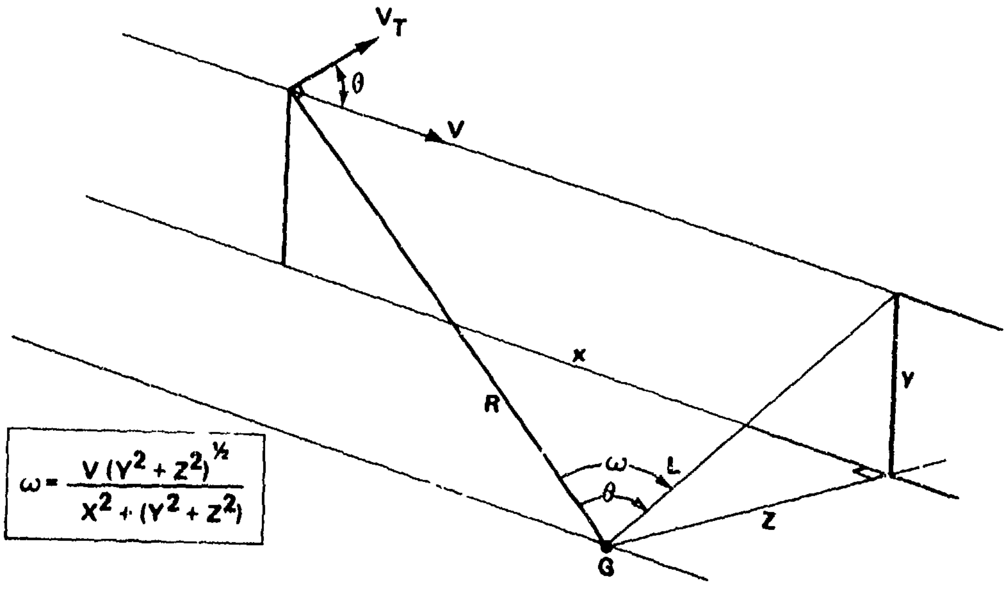
R - Slant Range

L - Slant Range at Crossover

X - Downrange Distance from Crossover

Y - Aircraft Altitude

Z - Offset Distance (Gunner to Crossover)



$$\omega = \frac{V\,(Y^2 + Z^2)^{1/2}}{X^2 + (Y^2 + Z^2)}$$

Figure A-1. Level Flight With/Without Offset

APPENDIX B
FLIGHT SEQUENCE SHEETS

FLIGHT SEQUENCE SHEET

Flight #	Rate	mv	Quad/ Clock	Initial Az Maneuver Pt.	Profile	VL	L	M	H	VH	Var Wt Lchr	Time	Notes
1	C	40	10		500/0	1	2	3	4	5	6	1337	
2	A	3	3		500/3R	1	2	3	4	5	6	1439	
3	C	40	10		500/0	1	2	3	4	5	6	938	
4	D	70	4		1000/0	1	2	3	4	5	6	1403	40 mv
5	B	20	2		1000/1.5R	6	7	8	9	10	1	1154	
6	A	3	3		500/3R	6	7	8	9	10	1	1235	
7	B	20	9		1000/1.5L	6	7	8	9	10	1	1159	
8	D	70	10		1000/C	6	7	8	9	10	1	1505	40 mv

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FLIGHT SEQUENCE SHEET

Flight #	Rate	mv	Quad/ Clock	Initial Az Maneuver Pt.	Profile	VL	L	M	H	VH	Var Wt Lchr	Time	Notes
9	C	40	2		1000/0	5	1	2	3	4	6	1130	
10	D	70	2		200/0	5	1	2	3	4	6	1207	70 mv
11	A	3	11		1000/1.5L	5	1	2	3	4	6	1423	
12	B	20	8		500/3L	5	1	2	3	4	6	1017	H DOWN
13	A	3	10		1000/1.5L	10	6	7	8	9	1	1351	
14	C	40	9		500/0	10	6	7	8	9	1	1244	
15	D	70			1000/0	10	6	7	8	9	1		
16	B	20			500/3L	10	6	7	8	9	1		

FLIGHT SEQUENCE SHEET

Flight #	Rate	mv	Quad/ Clock	Initial Az Maneuver Pt.	Profile	VL	L	M	H	VH	Var Wt Lchr	Time	Notes
17	A	3	2		1000/1.5R	2	3	4	5	1	6	1024	H down
18	A	3			500/3R	2	3	4	5	1	6		
19	B	20	10		500/3L	2	3	4	5	1	6	944	H down
20	B	20	4		1000/0	2	3	4	5	1	6	1455	VH no record
21	D	70	4		500/0	7	8	9	10	6	1	1432	
22	C	40	4		500/0	7	8	9	10	6	1	958	H down
23	C	40	8		1000/1.5L	7	8	9	10	6	1	1146	
24	D	70	4		1000/0	7	8	9	10	6	1	1410	65mv 9 missed

FLIGHT SEQUENCE SHEET

Flight #	Rate	mv	Quad/ Clock	Initial Az Maneuver Pt.	Profile	VL	L	M	H	VH	Var Wt Lchr	Time	Notes
25	C	40	10		1000/0	4	5	1	2	3	6	1511	30 mw
26	D	70			500/0	4	5	1	2	3	6		
27	C	40	8		500/0	4	5	1	2	3	6	1215	
28	A	3			1000/1.5L	4	5	1	2	3	6		
29	B	20			500/3R	9	10	6	7	8	1		
30	A	3	8		1000/1.5L	9	10	6	7	8	1	1030	H back on
31	B	20	8		500/0	9	10	6	7	8	1		
32	D	70			1000/0	9	10	6	7	8	1		

FLIGHT SEQUENCE SHEET

Flight #	Rate	mv	Quad/ Clock	Initial Az Maneuver Pt.	Profile	VL	L	M	H	VH	Var Wt Lchr	Time	Notes
33	A	3	8		500/3L	3	4	5	1	2	6	1137	
34	C	40	3		1000/0	3	4	5	1	2	6		
35	B	20	10		1000/1.5L	3	4	5	1	2	6	1446	
36	A	3	3		1000/1.5R	3	4	5	1	2	6	950	H-1 Mech Fail.
37	D	70			500/0	8	9	10	6	7	1		
38	B	20			500/3L	8	9	10	6	7	1		
39	C	40	3		1000/0	8	9	10	6	7	1	1250	
40	D	70	3		300/0	8	9	10	6	7	1	1222	70 mv.

APPENDIX C

EXAMPLE OF GUNNER ASSIGNMENT FORM

FLIGHTS 1 - 8

Flight	Gunner	Launcher	Clock	Completion Time	Remarks
1	1	VL	10		
2	1	VL	3		
3	1	VL	10		
4	1	VL	4		
5	6	VL	2		
6	6	VL	3		
7	6	VL	9		
8	6	VL	10		

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APPENDIX D

METEOROLOGICAL DATA

PROJECT: O'NEIL
15 MI EAST OF STONE CABIN

USA METEOROLOGICAL TEAM YUMA

Date 1 DEC 71 Time 0830 Page 1 of 1 Pages

Radiosonde/Surface Data				Winds Aloft Data ~~(Location)~~		
Altitude (FEET)	~~Pressure (mbs)~~	~~Temp (°C)~~	~~R.H.%~~	WIND SPD (MPS)	WIND DIRECTION	
SFC				4.5	300	
500				4.8	310	
1000				5.0	320	
2000				2.2	350	
3000				2.3	345	
4000				2.2	355	
5000				2.0	330	
6000				2.4	320	
		TIME	1235			
SFC				7.4	310	
500				8.8	310	
1000				10.5	315	
2000				7.5	320	
3000				3.9	090	
4000				1.8	010	
5000				— CALM —		
6000				— CALM —		

SELHU-MT-Y Form 2, 1 Jun 66. Replaces STEYP-MET Forms 2, 7, 8, 16, 21 which may be used until supply is exhausted.

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USA METEOROLOGICAL TEAM YUMA

Surface Meteorological Support

Page 1 of 1 Pages

Program: CAPT O'NEIL Date: 30 NOVEMBER 71 Position: 15 MI EAST OF STONE CABIN Elev(Ground): 340 Meters

Nr	Time (mst)	Amp Temp ~~(°C)~~ (°F)	Wet Bulb ~~(°C)~~ (°F)	Dep Wet Bulb	Rel Hum (%)	Dew Point ~~(°C)~~ (°F)	~~Soil Temp (°C) (°F)~~	Sky Cond	Vis	Sta Press (mbs)	Wind Dir (°T)	Wind Speed (KNTS)				
	0835	50.7	43.4	7.3	55	35.1		O'CAST	10+		CALM		HAZE			
	0900	49.9	42.9	7.0	56	34.9		O'CAST	10+		CALM		HAZE			
	1000	55.6	48.0	7.6	57	40.7		O'CAST	10+		CALM		HAZE			
	1100	59.2	48.9	10.3	47	39.0		O'CAST	15+		025	02	HAZE			
	1200	64.8	50.9	13.9	36	37.6		O'CAST	15+	968.0	200	03	HAZE			
	1300	63.9	51.1	12.8	40	39.2		BROKEN	15+	967.3	240	02	HAZE			
	1400	64.1	51.2	12.9	39	39.1		BROKEN	15+	967.0	CALM		HAZE			
	1500	60.9	50.0	12.9	41	37.4		BROKEN	10+	966.9	CALM		HAZE			

Observer: BEIDERBECKE & BLAIR Checker: Lo

SELHU-MT-Y Fo 1 Jun 66. Replaces ..EYP-MET Forms 10 and 35 which may be used until supply is exhausted.

PROJECT: CAPT O'NEIL
15MI EAST OF STONE CABIN

USA METEOROLOGICAL TEAM YUMA

Date 30NOV71 Time 0830 MST Page 1 of 1 Pages

Radiosonde/Surface Data				Winds Aloft Data		
Altitude (FEET)	~~Pressure (mbs)~~	~~Temp (°C)~~	~~R.H.%~~	WIND SPD (MPS)	WIND DIRECTION	
SFC				— CALM —		
500				0.8	290	
1000				1.2	295	
2000				1.5	175	
3000				2.5	125	
4000				2.4	085	
5000				1.5	095	
6000				1.2	110	
		TIME	1230			
SFC				— CALM —		
500				0.2	135	
1000				0.3	135	
2000				0.3	140	
3000				1.9	130	
4000				4.0	095	
5000				4.8	100	
6000				5.0	100	

SELHU-MT-Y Form 2, 1 Jun 66. Replaces STEYP-MET Forms 2, 7, 8, 16, 21 which may be used until supply is exhausted.

USA METEOROLOGICAL TEAM YUMA

Surface Meteorological Support

Page ____ of 1 Pages

Program: CAPT O'NEIL Date: 01 DECEMBER 71 Position: 15 MILES EAST OF STONE CABIN Elev (Ground): 340 Meters

Nr	Time (mst)	Amp Temp ~~(°C)~~ (°F)	Wet Bulb ~~(°C)~~ (°F)	Dep Wet Bulb	Rel Hum (%)	Dew Point ~~(°C)~~ (°F)	~~Soil Temp (°C) (°F)~~	Sky Cond	Vis (MILES)	Sta Press (mbs)	Wind Dir (°T)	Wind Speed (KNTS)	REMARKS
	0840	54.7	46.9	7.8	55	39.0		SCATTERED	15+	971.0	300	09	HAZE E
	0900	54.3	47.3	7.0	59	40.4		SCATTERED	15+	971.0	300	12	HAZE E, S
	1000	57.0	49.1	7.9	56	41.6		CLEAR	15+	971.2	300	14	HAZE, LIGHT BLOWING DUST
	1100	58.9	50.1	8.8	53	42.1		CLEAR	15+	971.8	320	19	HAZE, BLOWING DUST
	1200	60.5	50.1	10.4	47	40.3		CLEAR	15+	971.1	320	15	HAZE S
	1300	62.8	50.5	12.3	41	38.7		CLEAR	15+	971.0	320	14	HAZE E, S

Observer: BEIDERBECKE & BLAIR Checker: L

SELHU-MT-Y Form 3, 1 Jun 66. Replaces STEYP-MET Forms 10 and 35 which may be used until supply is exhausted.

REFERENCES

1. Chaikin, G., Chipser, J., and Rich, N., "Field Investigation of Gunner Aiming Error as a Function of Launcher Weight," US Army Missile Command, Redstone Arsenal, Alabama, February 1972, Technical Report No. RL-TR-72-4 (Unclassified).

2. US Marine Corps, "Evaluation of the Deployment of a Lightweight Air Defense Weapon System (LADS), Phase II, Plan of Test," Marine Corps Development and Education Command, Quantico, Virginia, October 1971 (Unclassified).